

AMENDMENTS TO THE CLAIMS:

No amendments are currently made to the claims.

LISTING OF CLAIMS:

Claims 1. – 315 (Canceled)

316. (previously presented) An automated optical inspection device suitable for inspection of an article, comprising:

at least one detector providing a polychromatic image output of at least a portion of an article; and

processing circuitry receiving said polychromatic image output and providing edge detection to sub-pixel accuracy operative to distinguish borders among regions of different color wherein said processing circuitry is operative to distinguish a border between a first color region associated with a first color population and a second color region associated with a second color population by identifying an approximate border location between said first color region and said second color region and determining a location of a border between said first color region and said second color region by using a preferred method for identifying the location of a border between said first color population and said second color population.

317. (canceled)

318. (previously presented) An automated optical inspection device according to claim 316, wherein said polychromatic image output comprises a color image represented using a color image representation method having a plurality of color defining characteristics, and

each said preferred method is selected from a plurality of available methods, and

the plurality of available methods includes, for each color defining characteristic within the plurality of color defining characteristics, a method comprising performing an edge locating method in a component of the color image associated with said color defining characteristic.

319. (previously presented) An automated optical inspection device according to claim 318 and wherein the edge locating method comprises a sub-pixel contour-element locating method.

320. (previously presented) An automated optical inspection device suitable for inspection of an article, comprising:

at least one detector providing an image output of at least a portion of an article having at least three different regions, each of which regions is distinguished at least by an optical characteristic detectable by said detector; and

processing circuitry receiving said image output and providing edge detection to sub-pixel accuracy operative to distinguish borders of at least two of said at least three different regions, wherein said processing circuitry receives said image output and provides edge detection to sub-pixel accuracy operative to distinguish borders of said at least three different regions.

321. (canceled)

322. (previously presented) An automated optical inspection device according to claim 320 and wherein said processing circuitry provides mapping based at least partially on said image output which identifies materials in each of said different regions having a common border.

Claims 323. – 324. (canceled)

325. (previously presented) An automated optical inspection device suitable for inspection of an article comprising:

at least one detector providing a polychromatic image output of at least a portion of an article;

processing circuitry receiving said polychromatic image output and providing at least one of the following inspection functionalities:

segmentation of said polychromatic image into a segmented color image comprising a plurality of color regions each having one of a plurality of representative color possibilities;

binarization of the segmented color image into a binary image including regions and borders;

morphological erosion of the regions to provide a skeleton representing the regions; and

assignment of color regions to elements in the skeleton;

wherein the processing circuitry is operative to superimpose the skeleton and the segmented color image, and to assign data representative of regions to elements in the skeleton as a function of the superimposition.

326. (canceled)

327. (previously presented) An automated optical inspection device according to claim 326 and wherein the processing circuitry is operative to assign data representative of regions to elements in the skeleton the superimposed location of an element of the skeleton in a color region.

Claims 328 – 353 (canceled).

354. (previously presented) An automated optical inspection device suitable for inspection of an article, comprising:

at least one detector providing a polychromatic image output of at least a portion of an article, said article comprising an electrical circuit formed on a printed circuit board; and

processing circuitry receiving said polychromatic image output and providing a color image representing said article, the color image comprising a map which indicates borders between different regions of an article and identifies materials in each of said different regions having a common border said different regions including uncoated metal conductors, coated metal conductors, uncoated substrate, and coated substrate.

355. (previously presented) An automated optical inspection device according to claim 354 and wherein colors of portions of said map indicate materials at various regions of the article.

356. (previously presented) An automated optical inspection device according to claim 354 and wherein said processing circuitry receives said image output and provides border indication to sub-pixel accuracy.

357. (previously presented) An automated optical inspection device according to claim 355 and wherein each color comprises a color chosen from among a predetermined possibility of colors.

Claims 358. – 359 (canceled)

360. (previously presented) An automated optical inspection device according to claim 359 and wherein the electrical circuit comprises a ball grid array substrate.

361. (previously presented) An automated optical inspection device according to claim 354 and wherein the patterned article comprises a lead frame.

362. (previously presented) An automated optical inspection device according to claim 354 and wherein the different materials include different metals.

363. (canceled)

364. (previously presented) An automated optical inspection device according to claim 354 and wherein the patterned article comprises an etched metal substrate.

365. (previously presented) An automated optical inspection device according to claim 354 and wherein the patterned article comprises an engraved metal substrate.

Claims 366. - 372. (canceled)

373. (previously presented) An automated optical inspection device suitable for inspection of a patterned article, comprising:

at least one detector providing an image output of at least a portion of a patterned article comprising a plurality of materials having detectable borders between the

plurality of materials said plurality of materials comprising at least three materials; and
processing circuitry receiving said image output and providing an inspection functionality comprising pattern analysis of image data relating to the borders to provide an indication of the presence of nicks and protrusions along said borders.

374. (previously presented) An automated optical inspection device according to claim 373 and wherein said patterned article comprises an electrical circuit.

375. (previously presented) An automated optical inspection device according to claim 374 and wherein said patterned article comprises a printed circuit board.

376. (previously presented) An automated optical inspection device according to claim 375 and wherein said printed circuit board comprises a ball grid array substrate.

377. (previously presented) An automated optical inspection device according to claim 374 and wherein said patterned article comprises a lead frame.

378. (canceled)

379. (previously presented) An automated optical inspection device according to claim 378 and wherein said materials include materials from the following group: uncoated metal conductors, coated material conductors, uncoated substrate, coated substrate.

380. (previously presented) An automated optical inspection device according to claim 374 and wherein said patterned article comprises an etched metal substrate.

381. (previously presented) An automated optical inspection device according to claim 374 and wherein the patterned article comprises an engraved metal substrate.

382. (previously presented) An automated optical inspection device according to claim 373 and wherein said inspection functionality comprising pattern analysis includes:

identifying an ordered plurality of points along a border defined by the image data relating to the borders, each of said ordered plurality of points having at least one neighboring point in the ordered plurality of points;

determining a normal direction to the smooth curve at each of said ordered plurality of points; and

identifying a point of said ordered plurality of points as being part of an irregularity comprising one of a nick and a protrusion based, at least in part, on a local normal difference comprising a difference between the normal direction to the smooth curve at said point and a normal direction to the smooth curve at said at least one neighboring point of said point.

Claims 383. - 395. (canceled)

396. (previously presented) An automated optical inspection device suitable for inspection of an electrical circuit, comprising:

at least one detector providing an image output of at least a portion of an electrical circuit comprising multiple materials; and

processing circuitry receiving said image output and providing an output indication of the presence of at least one predetermined material, said processing circuitry providing an output indication of the presence of at least two materials out of a group of at least three predetermined materials.

397. (previously presented) An automated optical inspection device according to claim 396 and wherein said electrical circuit comprises a printed circuit board.

398. (previously presented) An automated optical inspection device according to claim 397 and wherein said printed circuit board comprises a ball grid array substrate.

399. (previously presented) An automated optical inspection device according to claim 398 and wherein said electrical circuit comprises a flat panel display substrate.

400. (canceled)

401. (previously presented) An automated optical inspection device according to claim 396 and wherein said processing circuitry provides an output indication of the presence of at least three predetermined materials.

402. (previously presented) An automated optical inspection device according to claim 396 and wherein said processing circuitry provides an output indication of the presence of copper.

403. (previously presented) An automated optical inspection device according to claim 396 and wherein said processing circuitry provides an output indication of the presence of gold.

404. (previously presented) An automated optical inspection device according to claim 396 and wherein said processing circuitry provides an output indication of the presence of a solder mask material.

405. (previously presented) An automated optical inspection device according to claim 396 and wherein said processing circuitry provides an output indication of the presence of silver.

406. (previously presented) An automated optical inspection device according to claim 396 and wherein said processing circuitry provides an output indication of the presence of photoresist residue.

407. (previously presented) An automated optical inspection device according to claim 396 and wherein said processing circuitry provides an output indication of the presence of oxidized metal.

408. (previously presented) An automated optical inspection device according to claim 396 and wherein said image output represents a portion of the electrical circuit as viewed through a translucent overlay.

409. (previously presented) An automated optical inspection device suitable for inspection of a patterned article, comprising:

at least one detector providing an image output of at least a portion of a patterned article through a translucent overlay at least partially covering the patterned article; and processing circuitry receiving said image output and providing an output indication which is independent of the translucent overlay, said processing circuitry being operative to provide an indication of parts of the pattern covered by the translucent overlay and parts of the pattern not covered by the translucent overlay.

410. (previously presented) An automated inspection device according to claim 409 and wherein the patterned article comprises an electrical circuit.

411. (previously presented) An automated inspection device according to claim 410 and wherein the electrical circuit comprises a printed circuit board.

412. (previously presented) An automated inspection device according to claim 411 and wherein the printed circuit board comprises a ball grid array substrate.

Claims 413. – 436. (canceled)

437. (previously presented) Apparatus for automatically optically inspecting color images of objects, comprising:

- a sensor operative to acquire polychromatic images of an object;
- an image processor operative to process the polychromatic images and output a report indicating candidate defects and features chosen from among a predetermined set of features, and to provide an image of a region surrounding each said candidate defect and feature, said image processor including a binary image processor operative to process binary images generated from the polychromatic image, and a color image processor operative to process the polychromatic images.

438. (canceled)

439. (previously presented) Apparatus according to claim 437 and further comprising a morphological image processor operative to generate a skeleton map from a multicolor image derived from the polychromatic image.

440. (previously presented) An automated optical inspection device suitable for inspection of an article and comprising:

- at least one detector providing an image output of at least a portion of an article having at least three different regions, each of which regions is distinguished at least by an optical characteristic detectable by said detector; and

- processing circuitry receiving said image output and providing edge detection to sub-pixel accuracy operative to distinguish borders of at least two of said at least three different regions, wherein said processing circuitry provides mapping based at least partially on said image output which identifies materials in each of said different regions having a common border.

441. (previously presented) An automated optical inspection device suitable for inspection of an article comprising:

- at least one detector providing a polychromatic image output of at least a portion of an article;

- processing circuitry receiving said polychromatic image output and providing at least one of the following inspection functionalities:

- segmentation of said polychromatic image into a segmented color image comprising a plurality of color regions each having one of a plurality of representative color possibilities;

- binarization of the segmented color image into a binary image including regions and borders;

- morphological erosion of the regions to provide a skeleton representing the regions; and

- assignment of color regions to elements in the skeleton;

- wherein the processing circuitry is operative to assign data representative of regions to elements in the skeleton the superimposed location of an element of the skeleton in a color region.

442. (previously presented) An automated optical inspection device suitable for inspection of an article comprising:

- at least one detector providing a polychromatic image output of at least a portion of an article; and

processing circuitry receiving said polychromatic image output and providing a color image representing said article, the color image comprising a map which indicates borders between different regions of an article and identifies materials in each of said different regions having a common border, said different materials including different metals.

443. (previously presented) An automated optical inspection device suitable for inspection of a patterned article comprising:

at least one detector providing an image output of at least a portion of a patterned article comprising a plurality of materials having detectable borders between the plurality of materials, said materials include materials from the following group: uncoated metal conductors, coated material conductors, uncoated substrate, coated substrate; and

processing circuitry receiving said image output and providing an inspection functionality comprising pattern analysis of image data relating to the borders to provide an indication of the presence of nicks and protrusions along said borders

444. (previously presented) An automated optical inspection device suitable for inspection of a patterned article comprising:

at least one detector providing an image output of at least a portion of a patterned article comprising a plurality of materials having detectable borders between the plurality of materials; and

processing circuitry receiving said image output and providing an inspection functionality comprising pattern analysis of image data relating to the borders to provide an indication of the presence of nicks and protrusions along said borders, said inspection functionality comprising pattern analysis including:

identifying an ordered plurality of points along a border defined by the image data relating to the borders, each of said ordered plurality of points having at least one neighboring point in the ordered plurality of points;

determining a normal direction to the smooth curve at each of said ordered plurality of points; and

identifying a point of said ordered plurality of points as being part of an irregularity comprising one of a nick and a protrusion based, at least in part, on a local normal difference comprising a difference between the normal direction to the smooth curve at said point and a normal direction to the smooth curve at said at least one neighboring point of said point.